Measurement and Analysis of the $^{6}Li(n,t)^{4}He$ Cross Section

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The reaction $^{6}Li(n,t)^{4}He$ has important applications as a neutron flux monitor and as a breeder of tritium. Surprisingly, although its cross section has been well measured in the region below a few hundred keV where it is used as a standard, it is not so well known at energies above 1 MeV. A high-priority measurement at the Weapons Neutron Research (LANSCE-WNR) Facility has been to determine this cross section and its angular distributions in the MeV energy range.

Final values of the measured angular distributions for the $^{6}Li(n,t)^{4}He$ reaction were obtained by Nuclear Science (LANSCE-NS) in May 2008. The overall normalization of the data set (measured relative to the ^{235}U fission cross section) was determined to within about 5%. This information has been included in a large, multichannel R-matrix analysis of reactions in the ^{7}Li system at neutron energies up to 4 MeV in order to obtain better information about the $^{6}Li(n,t)$ integrated cross section. Some of the results are summarized in Fig. 1. The shape of the angular distribution around 2 MeV confirms the presence of the $J^{p} = 3/2^{-}$ resonance, which had been obtained earlier, and indicates that a pronounced shoulder in the integrated cross section due to that resonance is nearly 9% higher than that obtained in a previous LLNL evaluation [1], and more than 4% higher than the recent ENDF/B-VII/ IAEA evaluation [2].

Another result of the measurement and analysis is a reduction in the uncertainty of the reaction cross section in the region above 100 keV. This result is shown in Fig. 2, where the red curve gives the uncertainty estimate in 2006 that was based on the ENDF/B-VII evaluation and differences with the LLNL evaluation and other data, and the blue curve gives the present cross section uncertainties based on the covariances from the R-matrix analysis, including the new LANSCE-WNR differential cross sections. The reduction in uncertainty is almost a factor of three at 2 MeV, where the increased cross section due to the resonance may have applied significance.

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[1] Lawrence Livermore National Laboratory Evaluated Nuclear Data Library (1999).
[2] ENDF/B-VII/IAEA Standards Evaluation for the $^{6}Li(n,t)^{4}He$ Reaction (2006).
[3] M. Drosg, D.M. Drake, J. Masarik, *Nucl. Institute Meth. B* **94**, 319 (1994).
[4] R.L. Macklin. R.W. Ingle, J. Halperin, *Nucl. Sci. Eng.* **71,** 205 (1979). [ratio converted using revised $^{235}U(n,f)$ cross sections (2004)]

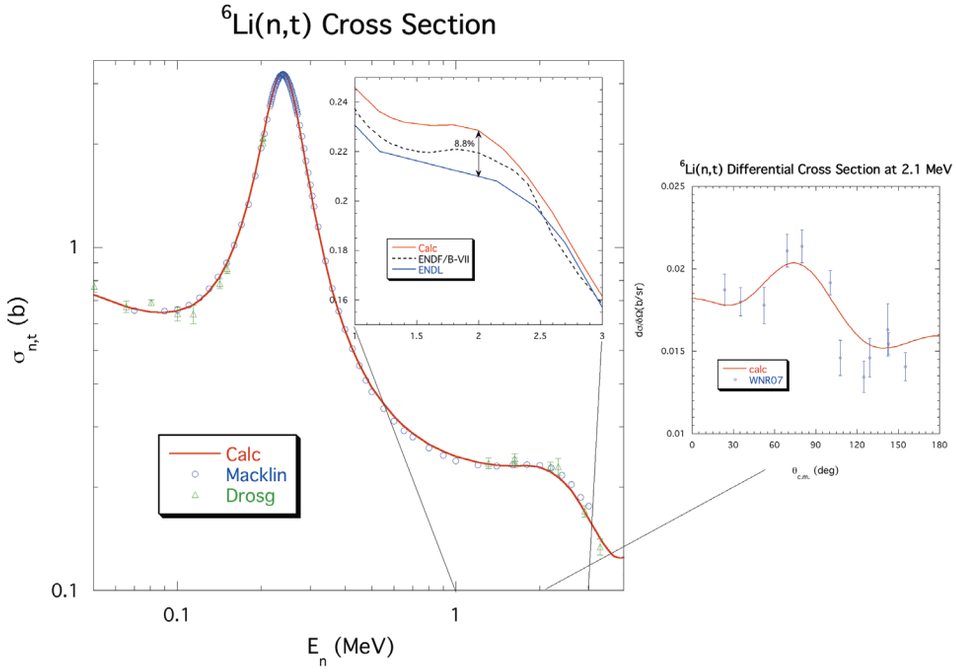

Fig. 1. Integrated cross sections for the ^{6}Li(n,t) reaction. The solid red line gives the calculation from the R-matrix fit. The blue curve in the insert is ENDL99 [1], and the dashed black line is the recent ENDF/B-VII (and IAEA standards) evaluation [2]. The measurements shown are from [3] (green crosses) and from [4] (blue circles). The fit to the new WNR measurement at 2.1 MeV is shown in the insert to the right.

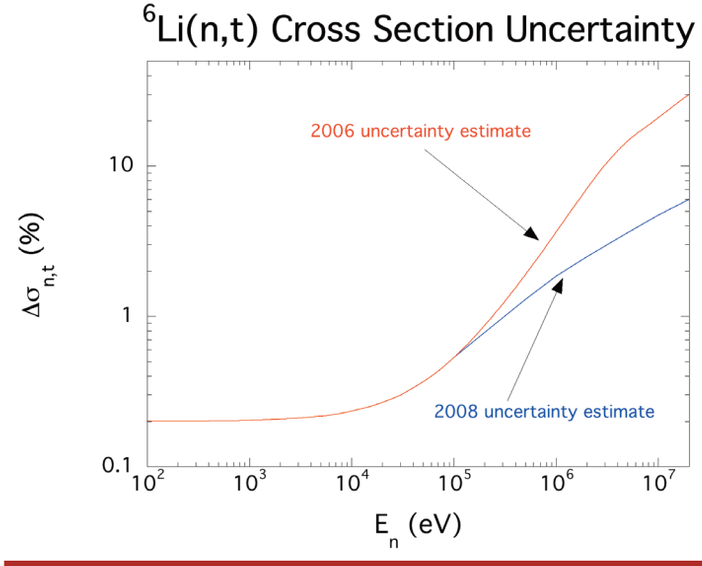

Fig. 2. Uncertainties of the evaluated ^{6}Li(n,t) cross sections obtained in 2006 (red curve) and in 2008 (blue curve).

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